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ABSTRACT

A research project is described that concerns "temporal adjustment" as one form of a non-wage adjustment in the academic labor market. Receipt of the doctorate, the number and length of post-doctoral fellowships, and the achievement of tenure are temporal factors in academic careers. The change in timing of these factors is a form of adjustment to market conditions. The length of time it takes an individual to receive a Ph.D. from the time he finishes his B.A. is examined. Data from surveys of the American Council on Education and the National Research Council are cited for the discussion of changes in time to Ph.D. over time. The data cover comprehensively all doctorates received from U.S. universities. The American Council on Education Survey of Teaching Faculty, conducted in 1973, provides information on people currently employed in academia. A statistical model that separates age effects of time to Ph.D. from date effects is described. Implications of estimation results for the formal model are discussed, and graphs are included. (SW)

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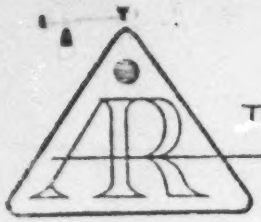

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TEMPORAL ADJUSTMENT IN ACADEMIC LABOR MARKETS:

TIME TO PH.D.

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April, 1978

The research of this paper was conducted as part of the Project on Quantitative Policy Analysis Models of Demand and Supply in Higher Education of the Carnegie Council on Policy Studies in Higher Education and was supported by the Ford Foundation. I would like to thank Luis Fernandez and Glenn Woroch for research assistance.

TEMPORAL ADJUSTMENT IN ACADEMIC LABOR MARKETS: TIME TO PH.D.

Introduction

There is a growing literature on salary determination in higher education. However, it is clear from even casual observation that the academic labor market is characterized by numerous forms of non-wage adjustments: tenure, the time to promotion, the achievement of recognition as a scholar by one's peers, and the probably unquantifiable benefits of belonging to a distinguished department, to name a few. The research described below is a progress report on an investigation of one non-wage adjustment in the academic labor market which we shall call temporal adjustemnt. Receipt of the doctorate, the number and length of post-doctoral fellowships, the achievement of tenure are all temporal waymarkers in academic careers. The change in the timing of these waymarkers is a form of adjustment to market conditions. To some extent, in fact, changes in timing of achievement in the academic labor market may serve as a compensating differential to individuals which makes academic employment appear more attractive than non-academic employment even at the cost of lower lifetime earnings. Changes in timing are also a non-wage way in which the supply of new entrants to academic employment can be controlled, in the case of time to Ph.D., or by which attrition can be encouraged, in the case of time to tenure. This is not to say that dissertations are not finally approved on the basis of excellence or that tenure is not very important because of its role in preserving academic freedom. Rather, the individuals who seek these rewards and the institutions that award them function in an economic environment. It would be surprising if we found no reflection of changes in market conditions in the timing of achievement in academic labor markets. In this paper, I shall examine what has happened to the length of time it takes an individual to receive a Ph.D. from the time he finishes his B.A.[1]

The time it takes a Ph.D. candidate to finish work for his degree is affected by both institutional behavior (finance, amount of graduate student teaching required, type of departmental standards, amount of time spent by the faculty with students, etc.) and by student behavior. There has been

[1] Throughout the paper I shall use B.A. to mean any baccalaureate degree.

very little previous work to attempt to elucidate this behavior, the outstanding examples being the work of Wilson (1965), Mooney (1968) and Breneman (1970). Descriptively, all these studies obtained similiar results: that time to Ph.D. is longer in the humanities than in the sciences, that men are much more likely to finish quickly than are women, that it is more likely to take longer to finish in larger programs than in smaller ones, and that although the amount and form of financial support has some effect on time to completion, it is only one of a number of factors. Breneman's work is theoretically the most interesting in that he puts forward a model of joint maximization of departmental prestige and resources which would predict the Mooney and Wilson results and which can also be helpful in thinking about adjustments in the Ph.D. production process to decline in the demand for Ph.D.'s. The primary drawback of the study is that it is entirely supply side determined, i.e., the determinants of student behavior are unchanging while departments adjust Ph.D. production to their perceptions of changes in the market. This may be the case. However, a discussion of student behavior would be interesting if only to investigate the question of whether such behavior would reinforce or dampen department action.

The work described below is work in progress and we do not yet have a formal model which incorporates student behavior. In such a model, however, we would have students attempting to minimize the cost of obtaining a Ph.D. subject to an aspiration level of quality of institution where they obtain their first teaching job <u>if</u> they go into academia. Student quality, as perceived by employers, depends on how long it has taken a student to finish his Ph.D. - perceived quality increasing over time to Ph.D. for a short period and then declining. Thus, there would be a period for which the marginal benefit of an additional year of Ph.D. work would exceed its marginal cost. As the market gets tighter, due to declining enrollments, employers demand a higher level of quality than they did previously. Perceiving this, students try to signal their quality by finishing their degree work in as short a time as possible. Doctorate producing departments, however, respond by encouraging attrition among marginal candidates and by restricting supply by lengthening programs. Theoretically, the effect on time to Ph.D. is not clear. Empirically, however, we observe that for

those who obtain the Ph.D. and teach in academia, time to degree is shorter. Data that combine both academic and non-academic Ph.D.'s show that for Ph.D.'s as a whole, the time to Ph.D. is increasing. This may result from the fact that fewer Ph.D.'s are going into academic work and that, compared to those going into academia, those going into non-academic employment are less concerned about time to Ph.D. as a signal to potential employers. Furthermore, to the extent that departmental resources are related to enrollments and to the extent that graduate students are a cheap source of teaching manpower, departmental behavior may encourage prolongation of time to degree by some students.

Time to Ph.D. is also important in academic labor markets for purely demographic reasons -- the longer it takes an individual to obtain his Ph.D., the shorter is his academic working life in a regular academic position. For example, if we assume that the age of college faculty is uniformly distributed between 30, and when a Ph.D., is received, and 65, when retirement occurs, the duration of the academic working life is 35 years and, in any given year, 1/35 or 2.8% of the faculty retire and are replaced. If the time to Ph.D. increases by two years, so that the lifetime in academia is shortened to 33 years, then, in the steady state, 3% of the faculty will retire and be replaced in any given year. The steady state effects are not especially large, but the transitional effect of a shortening by 2/35 (5.7%) of academic careers will mean a non-negligible increase in new hiring. It is possible that increases in time to Ph.D. are one sort of adjustment by which the supply of manpower to academia is rationed.

Although we do not as yet have the data or the formal model to test the interaction of student and departmental behavior described above, we do have observations on time to Ph.D. from a survey of those employed in academia that was conducted by the American Council on Education in 1973, as well as from the Survey of Earned Doctorates conducted by the National Research Council (NRC) for the National Science Foundation (NSF). In the following sections of the paper, I shall first discuss the changes in time to Ph.D. over time. A statistical model which separates age effects of time to Ph.D. from date effects is then described and estimated. The im-

plications of the estimation results for the formal model are then discussed.

Time to Ph.D. Over Time

Data on time from BA to Ph.D. by doctoral cohort collected by the National Science Foundation and by the Commission on Human Resources of the National Research Council (various years) are plotted in Figure 1. We can observe 6 different periods of behaviour of time to Ph.D.

I. Pre-1940. During this period, time to Ph.D. rose gradually in the humanities and social sciences while remaining relatively stable in the natural sciences. It is possible that the rise in some fields may have been due to Depression related financial problems of students.

II. 1940-1944. A period of declining time to Ph.D., most probably resulting from war-related pressure on those already "in the pipeline" to finish.

III. 1945-1952. Post-World War II increase in time to Ph.D. This was almost surely due to students going to war for 3-4 years after completion of the B.A. and before beginning graduate study. The actual time of study for the doctorate may, in fact, have been quite short. This shortening in the "production time" to Ph.D. may be reflected in the shorter times to Ph.D. observed after 1952.

IV. 1952-1961. During this period, the time to Ph.D. declined at first, probably due to the declining proportion of Ph.D.'s whose time to completion had been delayed by the war, and then began to rise after 1956.

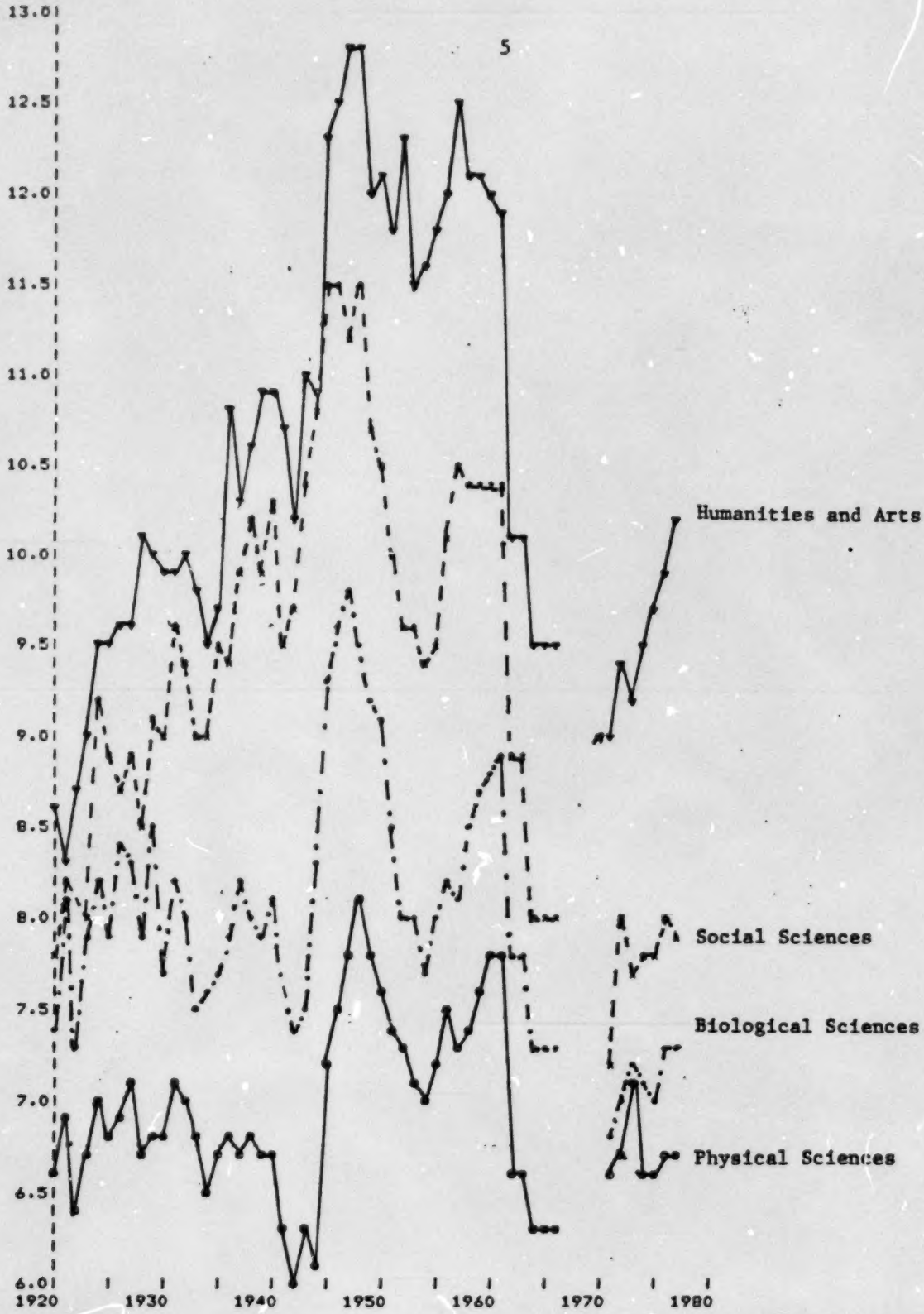
V. 1962-1968. Although the aggregate data are not available by broad field for this entire period, the pattern in individual fields is that the time to Ph.D. declined until 1968.

VI. 1968 to the present. Time to Ph.D. rose in almost all fields. It is the experience of the doctorate cohorts after 1956 that we are most interested in explaining in terms of market conditions. Although relatively unaffected by wars, fluctuations in time to Ph.D. can still be observed and we should seek to explain them on the basis of both institutional and individual behaviour.

Age and Date Effects and Time to Ph.D.

It is clear from examination of Figure 1 that there are field-specific

Figure 1. Time to Ph.D. - NAS-NRC data[2]



[2] Data aggregated by broad field are not published for 1967-70.

patterns of time to Ph.D., as is evident from the fact that the ranking by field of time to Ph.D. is unchanged even though the time to Ph.D. in any given field fluctuates. We would like to be able to isolate these field-specific patterns of time to Ph.D. from the fluctuations that result from varying conditions associated with the date at which an individual is a doctoral candidate but has not yet received his degree. In short, we would like to isolate the field-specific age pattern of time to Ph.D. or "age effect" from the effect of war or of market conditions specific to a particular date or "date effect". Age is defined as time from B.A. to Ph.D.. In an earlier paper, we developed a method in order to analyze time to tenure (2). In many ways the problem described above is analogous and I shall now briefly summarise it.

We have as data the date at which an individual received his B.A. and the date at which he received his Ph.D.* The numbers of people in a B.A. cohort who have not yet received their Ph.D. at a particular date, t, are arranged in a matrix whose dimensions are years since B.A., i, and date, t. An element in the matrix is P_{it}. If we consider a B.A. cohort, between any two years $P_{it}-P_{i+1,t+1}=S_{it}$ will have received a Ph.D.

With the S_{it} as observations of "successes", we seek to estimate ϕ_{it}, the probability of receiving the doctorate as a B.A. moves from age i at date t to age i+1 at date t+1. This estimated probability depends on an age effect, a_i and a date effect, b_t. In particular, a logistic function is fitted which assumes that:

$$\log \frac{\phi_{it}}{1-\phi_{it}} = a_i + b_t$$

or

$$\phi_{it} = \frac{e^{a_i + b_t}}{1 + e^{a_i + b_t}} = \frac{A_i B_t}{1+A_i B_t}$$

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[3] Of course, there are some people who will eventually receive their degree, but have not received it before the survey date. These individuals are included in a B.A. cohort up until 15 years after the B.A. Thereafter, they are dropped from the sample. This is equivalent to assuming that the age effect for any year beyond 15 is zero.

where $A_i = e^{a_i}$ and $B_t = e^{b_t}$

The logit function can be thought of as the log of the odds of getting a doctorate for an individual i years past his B.A. and the date effects can be thought of as a sort of "correction" to this odds ratio that depends on conditions existing at date t. If these conditions had no effect on a B.A.'s chance of receiving the doctorate, then the b_t would be equal to zero and the B_t equal to 1. The ϕ_{it} would then be independent of time or

$$\phi_{it} = \phi_i = \frac{A_i}{1 + A_i}$$

A date effect greater than 0 ($B_t > 1$) would mean that date-related conditions made it more likely that a candidate would get his degree in a particular year than would be predicted on the basis of years since the B.A. alone. A date effect less than zero, would mean that his chances were smaller than those that would result from the time since his B.A. alone.

Given the age and date effects, it is possible for any given date to calculate the corresponding probability frequency function and the cumulative distribution function for the time to Ph.D. We can find the medians of these distributions, and these "date-corrected" medians allow us to make comparisons across fields that are easily understood intuitively. The date-corrected median for year t can be interpreted as the median time to Ph.D. that would be experienced by the cohort that began doctoral study in year t <u>if</u> conditions did not change thereafter.

<u>Data</u>

The NAS-NRC data discussed above cover comprehensively all doctorates received from U.S. universities. The data that we will analyse in this paper is from the American Council on Education Survey of Teaching Faculty which was conducted in 1973. Thus, we will be looking only at people currently employed in academia. We would expect some differences between the two data sets for at least two reasons. On the one hand, to the extent that the Ph.D. is a credential required for academic work, we might expect academics to finish earlier and for time to Ph.D. to have smaller dispersion. On the other hand, since we include non-

Ph.D.'s in the last 15 years of our estimation, we may overstate time to Ph.D. to the extent that some of those non-Ph.D.'s will never obtain Ph.D.'s. Typically, we find that our sample has somewhat shorter time to Ph.D. than the NAS-NRC sample. However, the shape of fluctuations over time is very similar in the two samples, except in the late 1960's and early 1970's.

Results

The results of the estimation are displayed in the next 3 figures.[4] Figure 2 presents the age effects. We can see that one explanation (of a tautological variety) of the shorter time to Ph.D. in the natural sciences is the much higher probability of completion in the first 10 years. The median time to Ph.D. estimated assuming that the date effect is constant is shown in Table 1. Not only do the natural sciences have a shorter time to Ph.D., but the dispersion, as measured by the ratio of the median to the interquartile range, is smaller than in the social sciences or humanities.

The date effects are shown in Figure 3. The small date effects for the World War II B.A. cohorts are apparent. We see a similar pattern in date effects to that which we saw in median time to Ph.D. in the NAS-NRC data.[5] The date effects rise from 1946 to 1953. They then decline until 1960 when they rise rapidly, especially in the natural sciences, until 1970.

These date effects are more intuitively interpretable when we apply them to the age effects in the manner described above and construct date-corrected median times to Ph.D. These are shown in Figure 4. In the physical and social sciences, time to Ph.D. fell until 1970 to lows of 4.2 and 4.9 years, respectively. It then rose in the last year for which we have estimates. Time to Ph.D. in the biological sciences seems to fluctuate more, but it, too, declines

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[4] The numbers that are represented in the figures are presented in tables in Kuh (1978).

[5] The NAS-NRC data are arranged by Ph.D. cohort, while our data is presented by B.A. cohort. Thus, the decline in time to Ph.D. post-1951 Ph.D. cohorts is reflected by the rise in the date effects for the B.A. cohorts after 1947.

Figure 2. Age Effects - Time to Ph.D.

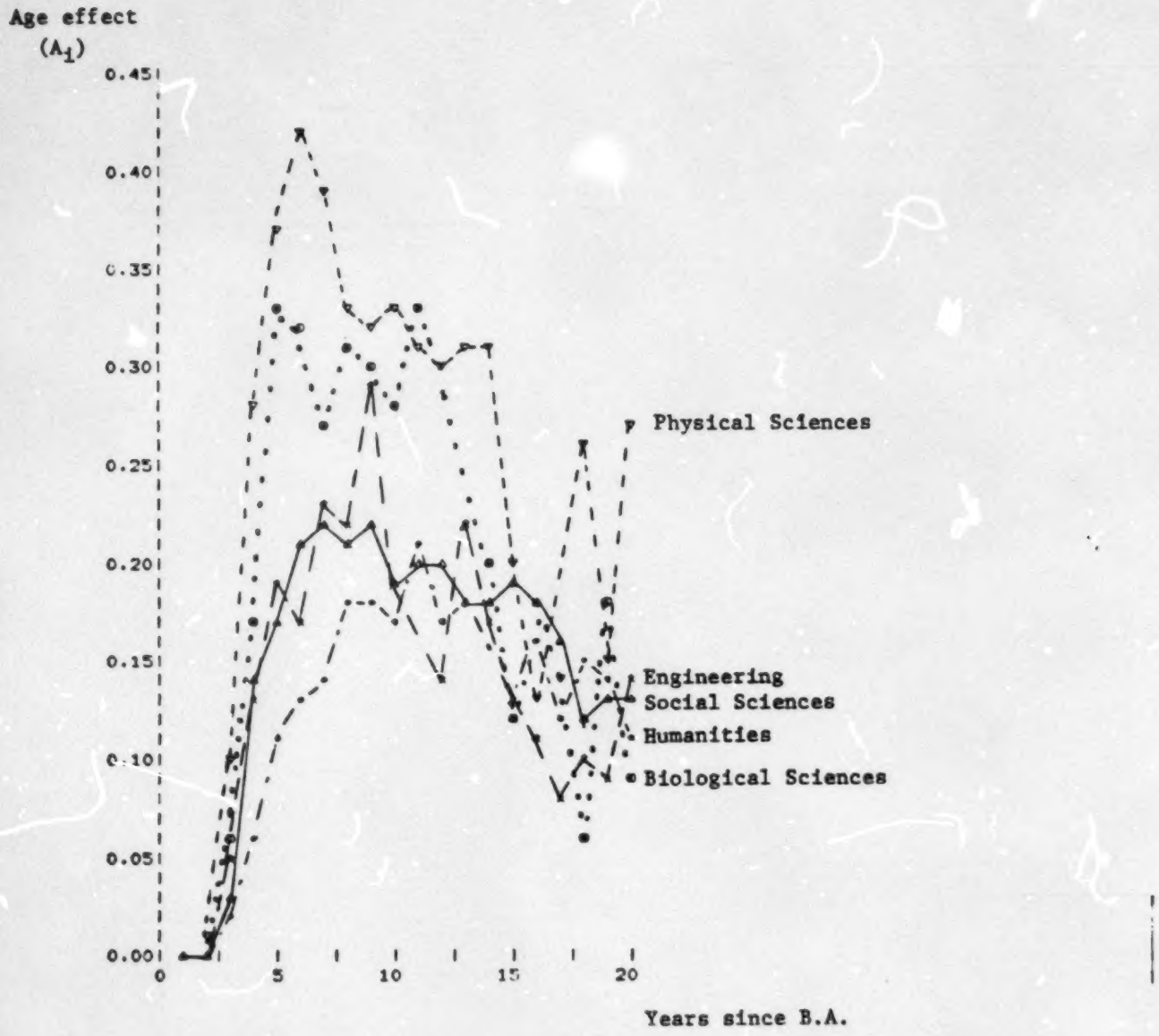


Table 1: Median Time to Ph.D. based on age effects alone.

	Complete Sample	Biological Sciences	Engineering	Humanities	Physical Sciences	Social Sciences
Median	6.85	5.71	6.78	8.33	5.06	6.82
Inter-Quartile Range	7.30	4.13	5.55	6.87	3.38	5.82
Ratio	1.07	.72	.82	.82	.67	.85

Figure 3. Date Effects - Time to Ph.D.

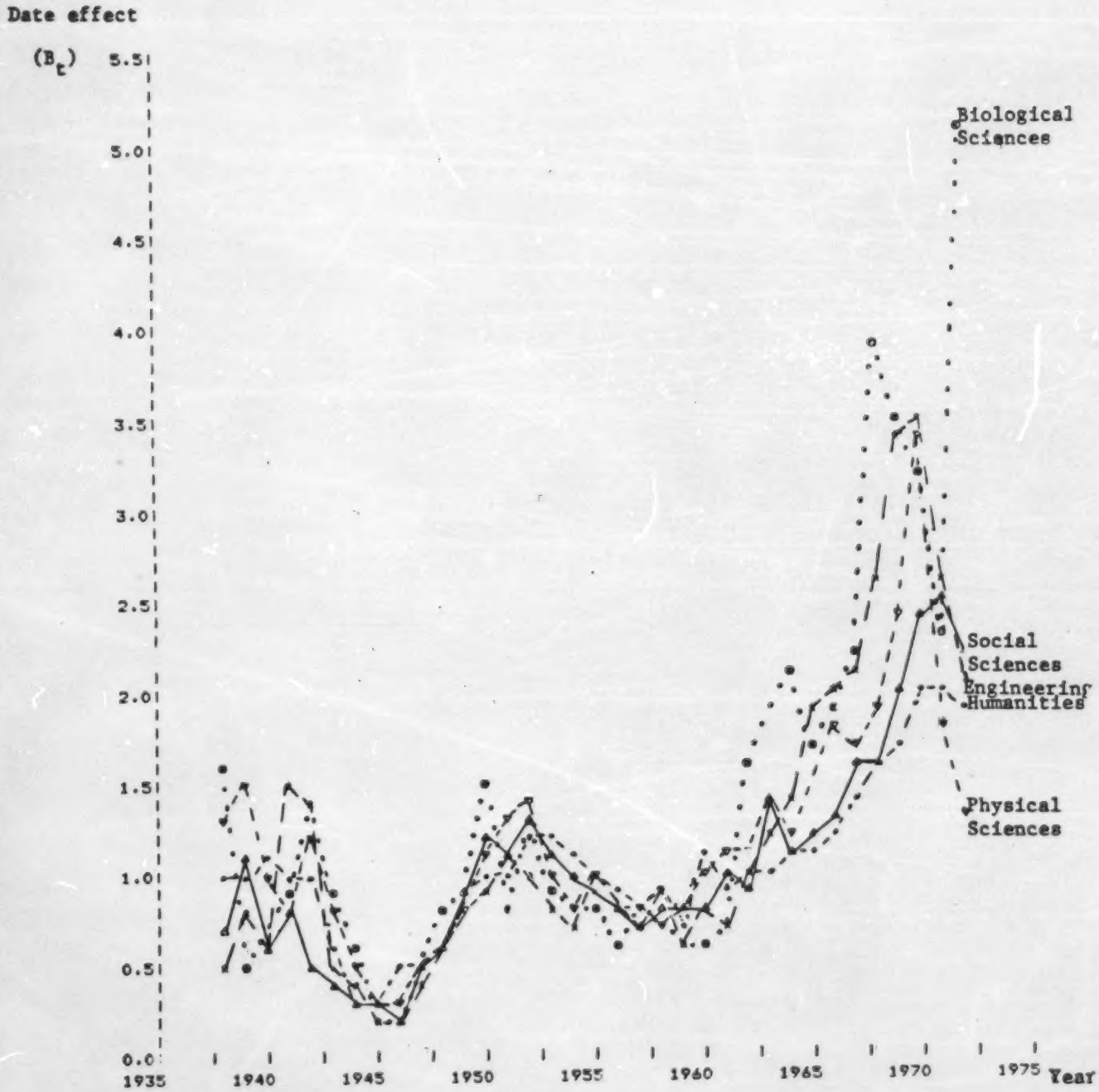
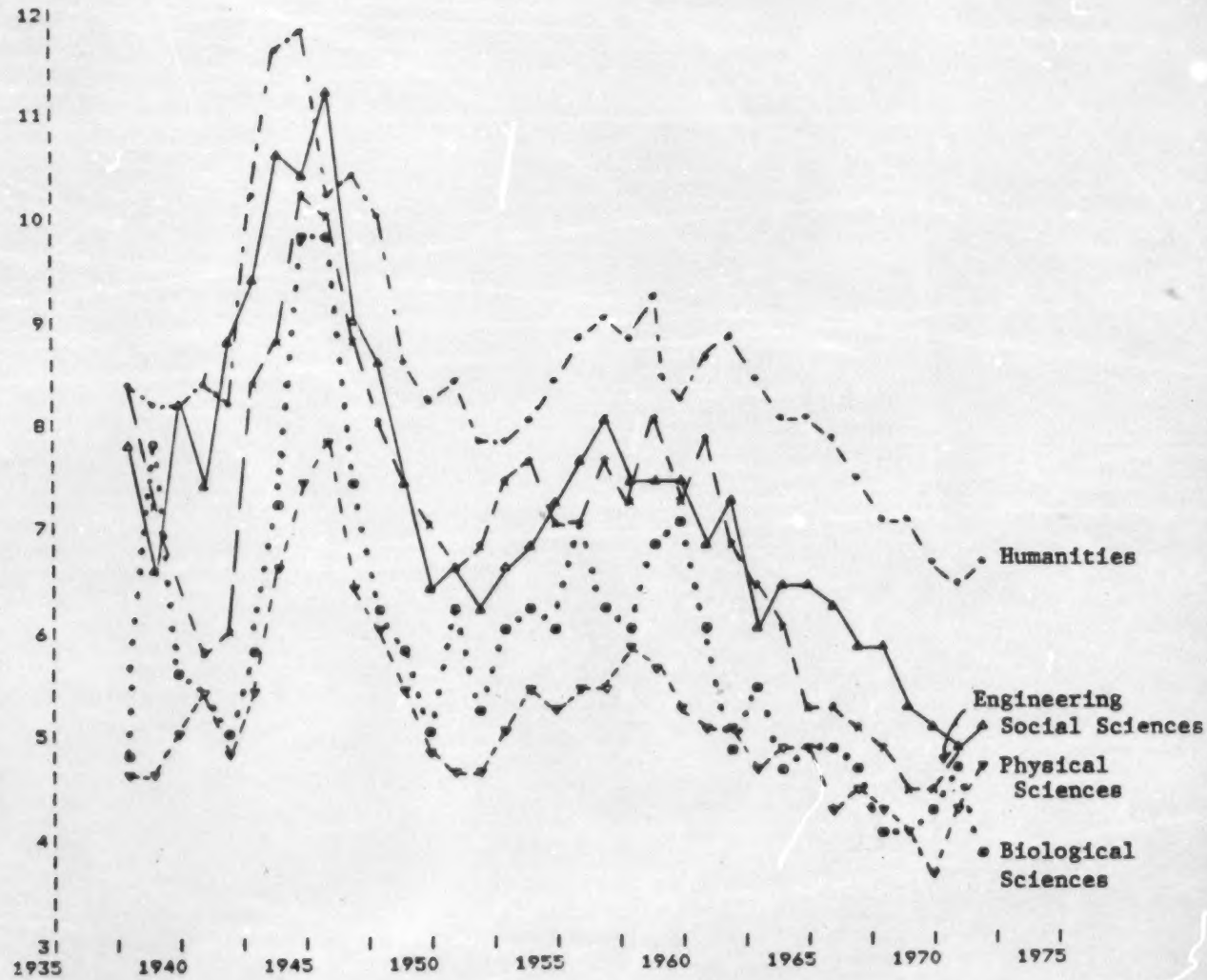


Figure 4. Date-corrected Median Time to Ph.D.



until 1969 and then rises. Time to Ph.D. in the humanities and in engineering begins to rise in 1972, also after declining during the 1960's. It is interesting to note from Figure 3, however, that the increase in the date effects for the humanities is much less pronounced than it is for the other fields during the 1960's.

One interesting question that we can examine with our estimation and with the NAS-NRC data is whether time to Ph.D. in the academic sample has behaved differently than in the sample of Ph.D.'s in all sectors. The answer is yes. The upturn in time to Ph.D. began earlier in the total sample in all fields. We do not yet have a way of making our estimates, which are on a B.A. cohort basis, and the NAS-NRC data, which are on a Ph.D. cohort basis, exactly comparable. One rough adjustment, however, was to ask "given the median time to Ph.D. in the NAS-NRC sample, in what year would that Ph.D. cohort have received the B.A." The reason this approximation is rough is that there is not a one-to-one mapping from Ph.D. year back to B.A. year. Particularly when time to Ph.D. is changing rapidly, two or more Ph.D. cohorts may, by this calculation, have received their B.A.'s in the same year. The B.A. years corresponding to the Ph.D. cohorts in the NAS-NRC sample for broad fields are given in Kuh(1978).The median time to Ph.D. in the social sciences from our estimates and from the adjusted NAS-NRC data are shown in Figure 5. In spite of the difficulties, it is evident that the upturn in time to Ph.D. is much more marked in the NAS-NRC sample than in the estimates of time to Ph.D. from the academic sample. It is clear that the next reseach step is to construct from the NAS-NRC data a B.A. cohort-based set of observations and to estimate time to Ph.D. with it. I think, however, that the difference mentioned above will persist and the remainder of the paper will speculate on the explanation of variation in time to Ph.D. overall and the difference between the academic and non-academic time to Ph.D.[6]

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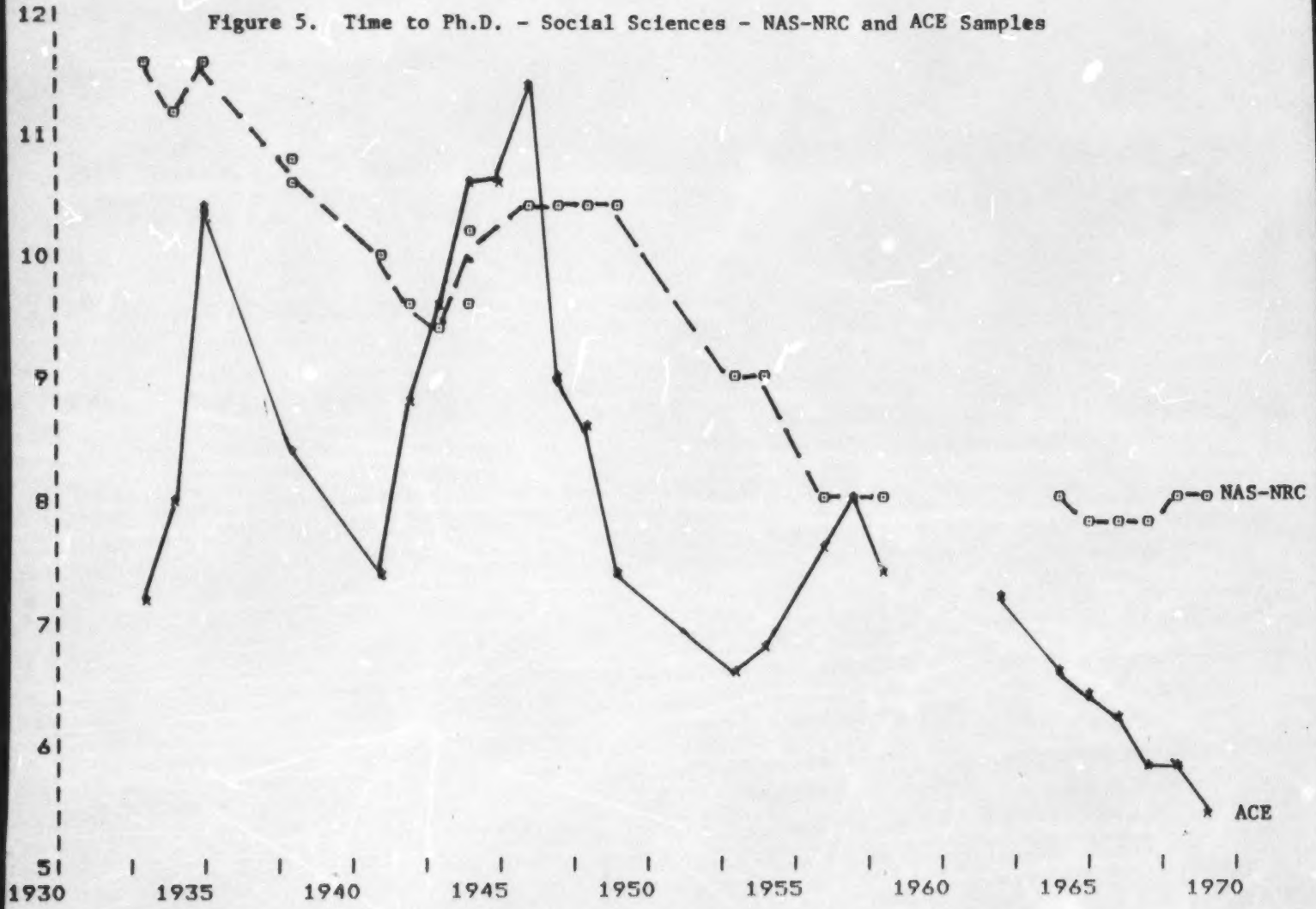
[6] Of course, we don't have observations on non-academic Ph.D.'s alone. However, since only an average of 40% of new Ph.D.'s in the sciences and 70% in the humanities in 1977 planned to work in an educational institution after receiving their doctorate, it is likely that the observed differences in time to Ph.D. from the two data bases are due, in large part, to difference in behavior of academic and non-academic Ph.D.'s.

Figure 5. Time to Ph.D. - Social Sciences - NAS-NRC and ACE Samples



Speculations on Causation

We shall limit our discussion to B.A. cohorts of the period after 1950, since it is clear from both data sets that the war had an effect on time to Ph.D. that had nothing to do with the market conditions that are of interest.

It seems likely that time to Ph.D. declined as the rate of increase in enrollments accelerated in the 1960's. I would speculate that there are two relations that result in this association. First, there is a supply response to changes in demand. In the face of a shortage of teachers, pressure was felt by doctoral institutions to "shorten the pipeline". There was an increase in support for graduate students from both public and private sources which had shortening the training period as a major aim. Second, there was an increase in demand for graduate training in response, in part, to the booming market for Ph.D.'s Many doctoral programs had more than enough qualified applicants. New doctoral programs were begun in many institutions, as well. To the extent that a doctoral program's prestige is enhanced by the number of its graduates, as well as their quality, there was internal pressure in graduate departments to increase throughput and thus create places for the well-qualified minions who were clamoring for admission. The increase in throughput was effected by shortening the period necessary for students to produce an acceptable thesis. It is interesting to note that although throughput was also increased by students leaving for teaching jobs without completed dissertations, the consequent delay in time to completion does not appear to have had the effect of slowing the decline in time to Ph.D. Rather, the decline in time to Ph.D. is greatest in those fields that grew most rapidly during the 1960's.

It is interesting to note that the effect of the Vietnam War is ambiguous. It is clear that in a period when deferments were given for graduate study, more students chose to go to graduate school than would have otherwise. For those not contemplating academic careers, the Vietnam War may have prolonged the period of graduate study since students would have wanted to extend as long as possible the duration of their deferment. On the other hand, graduate schools may have been better able to compete with professional schools in law and business for high quality students and better quality students may have been able to complete acceptable theses in a shorter period of time.

The end of the Vietnam deferment, the levelling off of graduate student support, and the deceleration of enrollments all occurred simultaneously in the late 1960's. There was no longer a booming market for Ph.D.'s. Graduate departments had to scramble to maintain the average quality of placement of their graduates. Furthermore, as academic employment declined in many fields, so did the importance of time to Ph.D. as a signal of quality for an increasing portion of the Ph.D. population. This speculation is consistent with the fact that time to Ph.D. continued to decline in the ACE sample, while it rose in the final 4-5 years of the NAS-NRC sample. Even in academia, however, time to Ph.D. now appears to be beginning to rise. It is quite possible that this may be a form of marginal adjustment that will shorten the duration of regular academic employment for future Ph.D.'s and thus allow a higher chance of academic employment for those who complete their Ph.D.'s when they complete it.

Future Research

The previous section is speculative because, in part, we still do not know very much about the operation of the "firms" that produce Ph.D.'s It is quite likely that the Breneman model in which graduate departments adjust output of students and time to degree in order to jointly maximize prestige and resources is a useful tool to describe behavior. As the academic market for new Ph.D.'s shrinks, however, the parameters in the model change. On the one hand, students are more anxious to finish earlier for three reasons: 1) there is less support, 2) a short time to Ph.D. is a signal of quality, and 3) it is more and more difficult to find a job without a Ph.D. On the other hand, 1) more students are going into non-academic jobs where time to Ph.D. is less important as a signal, 2) lack of student resources may result in more elapsed time to degree for the same amount of study relevant to the degree, and 3) suppliers of graduate education may increase time to degree for students as a sorting process, as a way to ration supply and as a way of exploiting relatively cheap labor when other research-related resources become more scarce.

The model that we have been discussing contains some elements that are observable and for which data exist, i.e. numbers of faculty engaged in graduate teaching, extent of research funding, numbers of graduate students enrolling and receiving degrees in any given year. We do not know, however, about the link between market change and departmental adjustment. How do departments

perceive market changes? There has been a great deal of publicity given to the bad prospects for new Ph.D.'s in academic labor markets. Stories appear in the press of hundreds of graduates clamouring for five jobs available in one field or another in the humanities. How does this "macro" environment translate into individual departmental behavior? The research into this side of the question is as much qualitative as it is quantitative.

Changes in time to Ph.D., in themselves, have no particular normative significance. However, in a world where annual doctorate production increased by an average annual rate of 13% between 1965 and 1973 but has been decreasing at an average annual rate of 1.5% during the past 4 years, change in time to Ph.D. is, to at least some extent, a form of market adjustment. If we can understand the causes of such change, we should be better able to predict the course of graduate education in future years.

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